X. *On the Life-history of* Lonchaea chorea, *Fabricius*. By Alfred E. Cameron, M.A., B.Sc., Government Research Scholar, and Honorary Research Fellow, the University of Manchester.

[Read October 18th, 1912.]

Plate XI.

## Introductory and Historical.

Towards the end of the year 1911 some cow-dung amongst which small white Muscid larvae had been observed feeding, was received by me from Mr. Saunders of the Agricultural College, Holmes Chapel. The adults were reared, and Mr. Collin kindly identified them as *Lonchaea chorea*, F. The larvae were transferred to wire-gauze breeding-cages with a fresh supply of cow-dung and the temperature kept fairly high, ranging from 70° to 78° F. Under those favourable conditions of food and temperature the life-history was soon completed, pupation occurring in about twelve days and the adults appearing about ten days later. In the laboratory the whole development from the egg to the imago occupied about thirty days at the outside, where temperature and other conditions of nutriment and humidity were favourable.

Bouché * in 1834 was the first to give an account of the life-history of *L. chorea*, and it might be useful to repeat his brief description.

"Die Larve ist walzig, vorn verjüngt, glatt, weiss. Bauchgelenkstücke gerieselt. Prothorax = Stigmata gelb, sieben- bis zehntheilig. Afterabschnitt schief, nach unten gestutzt. Die gelbbraunen erhöheten Stigmenträger sitzen an der obern Kante der Abstutzungsfläche und haben gebreite Stigmen.—Lange 3 Linien.—Man findet sie den Herbst und Winter hindurch unter fauler Baumrinde.

"Ich habe noch bei keiner Fliegenlarve eine so schöne und zusammengesetzte Luftröhren-Verbindung gesehen, wie bei dieser. Um sie anschaulich zu machen, füge ich auf Taf. vi, Fig. 1. eine Zeichnung davon bei.

* Bouché, P. Fr., Naturgeschichte der Insekten, besonders in Hinsicht ihrer ersten Zustande und Puppen, p. 94, Taf. vi, fig. 1.

"Die Puppe ist ein längliches, quergestricheltes, hellrothbraunes Tönnchen. Der Thorax ist gerieselt. Der Afterabschnitt porkat, mit vorstehender, schwarzbraunen Stigmenträgern.—Lange $1\frac{1}{2}$ Linien.—Nymphenzeit vierzehn Tage."

Bouché gives but one figure, an admirable representation of the branching tracheal system of the larva, to which he refers in his text. As regards the breeding habitat, Bouché says he found the larva under the bark of trees, whilst Scholtz * discovered it amongst cow-dung. Mr. Austen informs me that he has bred the imago from larvae feeding on diseased bulbs of *Crinum* and *Brunsvigea cooperi*, to which it would seem they are rather partial, and also from others in a rotten cabbage. Farsky † discovered the larvae in a crop of beetroot suffering from so-called "*Kernfaule*" or core-rot.

### The Egg.

The egg of *L. chorea* is very similar in size and appearance to that of many of the *Anthomyiidae*, bearing on its outer delicate case a pretty ornamental sculpturing composed of minute hexagonal areas. By reason of their pure white colour they were easily recognisable in the breeding-cage amongst the cow-dung, where they were deposited by the imagines. Farsky gives their accurate measurement, stating their size to be 0·8670 mm. long and 0·2500 mm. broad. After a period of about eight to ten days under ordinary conditions, the larva bursts the chorion longitudinally and emerges. In the laboratory, probably on account of the high temperature, only about half that time elapsed between the act of oviposition and the appearance of the larvae.

### The Larva.

A certain number of the larvae were placed in a cool-house where the temperature did not rise above 50° F., and usually, indeed, the temperature remained a few degrees below this—during the night often falling well below 40° F. It was observed that the larvae under these conditions continued to feed, and pupation did not begin until as many as sixty to seventy-two days had passed. It would thus

* Scholtz, Ent. Zeit. Breslau, 1–3 Bd., p. 10.

† Farsky, Verh. zool.-bot. Ges. Wien (1879), pp. 101–107, pl. iii, figs. 1–7.

appear that a lowering of the temperature effects a retardation of development, the larval stage at higher temperatures (70°–78° F.) occupying but ten to fourteen days. Again, it seems rather anomalous that although the period of feeding is five to six times as long, the larvae never attain the same size, but always remain somewhat smaller, the pupae and imagines being correspondingly diminutive. Several other authors have experienced like results in the case of other Muscid larvae. Another factor associated with development is humidity. Variations in humidity have a similar effect to variations of temperature, a large amount of moisture acting as a check on development, just like a low temperature. Where there is little moisture development is hastened to a remarkable extent; but it must be also observed that a certain amount of moisture is always necessary to the larva for the proper assimilation of its food.

Farsky observed that the larvae feeding on decaying beetroot in the open, required six to eight weeks for their development according to the weather conditions.

The full-grown larva (figs. 1 and 2) measures 9 mm. in length, and is of the cylindrical form usual in Muscid larvae, gradually tapering postero-anteriorly, the posterior end rounded and rather obliquely truncate. The colour is dull white, the cuticle being perfectly smooth, devoid of hairs and exhibiting a faint iridescence in specimens preserved in alcohol. There are in all twelve very distinct segments, including the head or most anterior. The organs of locomotion consist of small ellipsoidal areas (figs. 1 and 2, kw.) interposed between each two segments, commencing between the third and fourth. These are beset with transverse rows of minute, closely-set spines, which give the larva a grip on any roughnesses of the surface over which it may chance to be travelling. They are the "Kriechwülste" or "Kriechschwielen" of German authors as opposed to the "Zwischensegmente" or tween-segments by which are meant small intercalary segments between any two true adjacent segments. At the posterior end (fig. 3) the larva of *L. chorea* is devoid of tubercles or protuberances of any kind and herein differs from the larvae of other members of the *Sapromyzidae* which possess a transverse row of four conical tubercles on the penultimate segment, whilst many of the *Lonchaeinae* have small wart-like projections on the last segment behind the stigmata. The two dark-brown, almost sessile posterior spiracles (figs. 3 and 4, p. sp.) are of the shape of equilateral triangles with the angles rounded off

They are situated rather dorsally on the terminal segment and consist of a comparatively broad, circular, chitinous band enclosing a small space in which lie three slits situated almost at right angles to each other. The larvae of the Sapromyzids proper are distinguished from those of *Lonchaea* by the presence on the posterior aspect of the last segment, of two 3-segmented tubercles. Between these is situated the pair of cylindrical projections bearing the spiracles at their extremities. Brauer * describes small wart-shaped processes behind the spiracles of the larvae of *Lonchaea*. The palmate funnel-shaped prothoracic stigmata (figs. 1 and 2, pt. sp) of a pale yellow colour, are provided with nine circular orifices; but the number may vary from seven to ten (Bouché), eight to ten (Brauer).

Farsky gives a very interesting account of the behaviour of the larva which he observed attacking the roots of diseased sugar-beet previously encroached upon by a nematode worm. In fact, it was the investigation of the diseased conditions caused by the nematode, which led him to detect the presence of the maggot. The eggs are laid at the base of the leaf-petiole in small clusters; the larva on emerging penetrates the petiole and instinctively it seems, following the course of the leaf-traces downwards, makes its way into the root, attracted in some curious way to the decaying tissue where the nematode has previously been at work. How the larva is made aware of the internal decay consequent on the presence of the nematode, is rather puzzling, seeing that no trace of the internal putrescence may be apparent on the periphery of the root.

The same author carried out a series of experiments which go to prove the wonderful vitality of the larva. The delightful unconcern and apathy which it showed under most trying conditions, would seem to be scarcely credible. Taking a larva, he plunged it three times running into a watch-glass containing absolute alcohol which was then allowed to evaporate; but the unhappy larva successfully faced the ordeal and came through it alive. Having recovered uninjured from the hardening effect of this unwonted medium, the succeeding attempts to deprive it of life seem comparatively trivial. Keeping it in water for four hours had no effect, as was amply demonstrated on its subsequent removal, by its vigorous movements. Even

* Brauer, Die Zweiflügler des kaiserlichen Museums zu Wien, p. 41, 1883.

fourteen hours of an aquatic life did not trouble it much. An all-night sojourn in a weak solution of alcohol consisting of water mixed with beer, also failed to disturb its equanimity; for it became as active as ever when withdrawn. Granted a short rest and allowed some nourishment, the larva refreshed, successfully tackled the final test, a day's submersion in undiluted beer. Having emerged with flying colours, or, should we say, retaining all its cuticular iridescence, it was restored to a diet of decaying beetroot, when it shortly afterwards pupated and completed its metamorphosis. Such a tenacity of life is not, I should imagine, shared by many larvae.

### The Pupa.

After becoming full grown the larva rests for a short time previous to pupating, when it undergoes contraction from 9 mm. to 5 mm., assuming the barrel shape characteristic of Muscid pupae. The pupae vary in size, the average size being 5 mm. in length by 1·9 mm. broad. During the process of pupation, which occupies about a couple of hours, the colour changes from a creamy white to a reddish brown, and as the development of the imago proceeds within, the puparium gradually becomes darker. Most of the larval characters are discernible in the pupa; but owing to the shrinkage which has occurred, the relative position of organs has been affected. The prothoracic, lateral spiracles are now situated almost quite at the anterior end of the pupa, and two small projections posteriorly, denote the position of the posterior spiracles. Inside the breeding-cages the larvae pupated in the drier portions of the cow-dung.

At the termination of twelve to fourteen days under the laboratory conditions employed, the imagines were ready to emerge, and they made their exit from the pupa cases by a T-shaped split at the anterior end,—the fly employing the ptilinum to push the valves apart.

Under ordinary natural conditions Farsky states that the pupal period of development lasts for three and a half to five weeks, and in moist, damp weather it may be even more prolonged. It must be always borne in mind that a difference in the nature of the food of the larva may be of radical importance in determining the length of the period occupied by the insect in its metamorphosis, where other conditions of temperature and moisture are equal. In

Farsky's experiments the development occupied a rather longer time than I experienced in mine. This may be in part, I think, associated with the fact that the food on which he reared his larvae, consisted of pieces of decayed beetroot, whilst in my experiments, the larvae may have found a richer diet in the nutritious cow-dung. On this account their development may have been greatly hastened, all the more so when we take into consideration the high temperature prevailing in the laboratory where my breeding-cages were kept. The complete metamorphosis was gone through in not more than four to five weeks; whereas, Farsky states that the time required is ten to fourteen weeks. But I must add that this agrees very well with the time occupied in the development of the imagines which I reared in the cool house at the lower temperature of 50° F. In this case, at least ten weeks passed between the act of oviposition and the appearance of the adult.

### Buccal Apparatus of Larva.

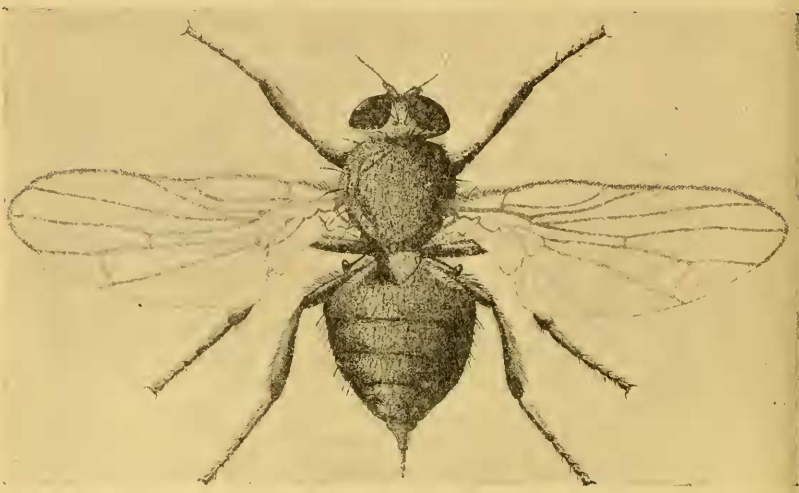
The elaborate mouth-parts (fig. 7) consist of a number of pairs of sclerites which become more strongly chitinised and tend to fuse, as the larva matures. Projecting through the oral aperture and surrounded by the rugose areas of the mouth, is a pair of parallel, robust, sickle-shaped hooks (md. s.) to which there articulates distally the hypostomal sclerite (h. s.) bearing two small teeth on its ventral aspect. Ventro-posteriorly a pair of small irregular dentate sclerites (d. s.) articulates with the falciform hooks. The hypostomal sclerite has two arms connected by a slender cross-bar, each arm fitting into a space between two anterior ventral processes of the corresponding cephalo-pharyngeal sclerite (c. p.). These paired cephalo-pharyngeal sclerites have attached to their anterior dorsal extremities, a small perforate sclerite (pf. s.) which serves to unite them; whilst posteriorly, a deep bifurcation divides each sclerite into a slender dorsal (d. p.), and a broad ventral process (v. p.). The whole of the mouth-apparatus is left behind, attached to the dorsal anterior valve of the puparium, when the imago emerges.

### The Imago.

From the very full descriptions of Farsky and Schiner *

* Schiner, Fauna Austriaca. Die Fliegen, vol. ii, p. 91.

the imago may be easily identified by the aid of my figure. The ovipositor is rather characteristic.



*A. E. C. del.*

Lonchaea chorea ♀ × 10 (*amount magnified*).

Many authors consider that *Lonchaea chorea*, F., is merely a variety of *vaginalis*, Fln. Schiner says in his account : " *L. chorea* is very closely related to *L. vaginalis*, in fact they may be considered as varieties of one and the same species : at least, no author has been able to give any definite characters which will delimit the one from the other. . . . *L. chorea* is smaller than *L. vaginalis*; wings transparent, with weak veins. . . . Quite similar to the preceding species (*L. vaginalis*), from which it differs only in the relatively shorter ovipositor, and also apparently in the fact that the humeral cross-vein lies nearly opposite to the origin of the anterior branch of the auxiliary, whilst in *L. vaginalis* the humeral cross-vein is decidedly anterior." In my opinion *Lonchaea chorea*, F., and *vaginalis*, Fln., are merely synonymous names for one and the same species, and in the " Katalog der Palaarktischen Dipteren," Bd. iv, pp. 86–87 (1905), they are regarded as such. Mr. Austen kindly refers me to the fact that this synonymy is shown on the labels attached to the species of *Lonchaea*, in the Diptera collection of the Natural History Museum, South Kensington. I have had the opportunity of examining the specimens there.

## Position of the Lonchaeidae.

As regards the systematic position of the *Lonchaeidae* there would appear to be some difficulty. Originally united with the *Sapromyzidae*, they have been more recently separated off by Loew, Becker and other authors as a distinct family because of certain small differences. But Williston in his "Manual of North-American Diptera" (1908) includes in the *Sapromyzidae* the sub-families *Sapromyzinae* and *Lonchaeinae*.

## Economic Status.

*L. chorea* is not known to cause much damage, although it may be very extensively found at times attacking crops of diseased beetroot. It does not frequent human habitations; so that it could not be classed with the disease-carrying house-fly which it resembles to a certain extent in its breeding habits. Rather should we class it in that large group in which are included all "followers of decay," in that plants, such as beetroot and certain Monocotyledons, which have been previously attacked by fungus or other destructive agencies, are liable to have the injury accentuated by the larvae of this fly. The larvae may be transmitted by the use of infected dung for the manuring of soils in which the crops liable to attack, are cultivated.

If the dung be mixed with a small quantity of some chemical soil-fertiliser, such as commercial sulphate of ammonia, the larvae will be killed off; and at the same time the percentage of available nitrogen will be increased by the admixture of the chemical. Other dressings may be used with equal effect, such as the potash salts, superphosphate of lime, etc.; but care must be taken to use them in fertilising quantities, otherwise serious damage might be done to the plants. The use of fertilisers as insecticides is by no means new, and in America at least, they have been long known to be effective against cutworms, wireworms, scale-insects and aphides

## Explanation of Plate XI.

Fig. 1. Ventral aspect of larva of *Lonchaea chorea*: numerals denote number of segment.

pt. sp. prothoracic spiracle; lw. locomotory areas (Kriechwülste); an. anus.

2. Lateral aspect of same to show the position of posterior spiracles (p. sp.).
3. Posterior aspect of same showing posterior spiracles (p. sp.) greatly magnified.
4. Camera lucida sketch of posterior end of larva of *L. chorea* to show structure of posterior spiracles (p. sp.). Canada balsam preparation.
5. This figure makes clear the relation of the posterior spiracles (p. sp.) to the last segment.
6. Pupa of *L. chorea*—dorsal view.
7. Camera lucida sketch of the mouth armature of the mature larva after treatment with caustic potash.

   md. s. mandibular sclerite; d. s. dentate sclerite; h. s. hypostomal sclerite; pf. s. perforate sclerite; c.p. cephalopharyngeal sclerite; d. p. dorsal process of cephalopharyngeal sclerite; v. p. ventral process of same.
8. Prothoracic stigma of mature larva